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BIRD-RESISTANT GRAIN SORGHUM: A NEW CROP FOR OHIO

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INTRODUCTION

Recent research effortts indicate that grain sorghum (*Sorghum bicolor)* may be a desirable crop in Ohio. Its place is limited but presently available bird-resistant hybrids have performed favorably in areas where corn (*Zea mays*) production is hazardous because of damage by red-winged blackbirds *(Agelaius phoenicus)*.

Grain sorghum (sometimes called milo or combine maize) has been grown in the United States since the 1930's when dwarf types were developed which could be mechanically harvested. Hybrids were developed in the 1950's and since that time acreage has increased substantially. Most grain sorghum is grown in areas too dry for economic corn production, primarily in the Southwest.

Grain sorghum is an annual grass with growth habits similar to those of corn. It withstands drought and heat better than corn, thus explaining its primary area of production.

The grain is produced terminally in a panicle commonly called a head. The grain is small relative to corn but is very similar in composition. It is used primarily for animal feed. Most research indicates that sorghum grain is slightly inferior to corn as an animal feed, depending somewhat on the animal species under consideration.

The grain of most sorghum varieties is white, red, or brown. Other colors are known but are not common.

The plant varies from approximately 24 to 60 inches in height, depending upon variety and environmental conditions. A given variety tends to grow taller in the northern, relatively humid areas of the United States.

Ideal growing conditions for grain sorghum are very similar to those for corn. Highest yields are reported from trials conducted in the Corn Belt or under irrigation in the Southwest. It frequently yields as high or higher than corn grown under similar conditions. It has not been widely grown in the Corn Belt because corn is considered superior in feed value and because of harvesting and drying problems with sorghum which are accentuated by wet, cold falls. Tradition may also play a part.

Research in Ohio on grain sorghum began in 1966 because it was thought that bird-resistant sorghum hybrids might be an alternate feed

Corn and grain sorghum varieties from an area having heavy bird losses. First and third sorghum heads and corn were bird-susceptible.

Bird-susceptible sorghum in the plot on the left was a complete loss. Bird-resistant sorghum on the right was not damaged.

grain crop to replace corn in areas where corn was being heavily damaged by red-winged blackbirds and associated species.

Corn has suffered increasing damage from red-winged blackbirds for the past several years. Damage has been most severe near Lake Erie but is evident in many areas of Ohio, particularly near bodies of water. Most of the damage to corn is done during the milk and soft dough stages when birds feed on the grain. The uneaten kernels on damaged ears are exposed to the elements and frequently mold or become weathered. In either case, the quality of harvested product is reduced.

Farmers suffer direct loss from the bird damage and also from costs associated with bird control measures. State losses have not been accurately estimated but probably amount to several million dollars per year. Losses of 75 percent on a given corn field are not uncommon near Lake Erie if control measures are not used.

The bird-resistant grain sorghums became commercially available about 1963. They were developed in the southeast United States for areas in which bird damage has been a perennial problem.

The bird resistance is due to the high tannin content in the seedcoat of the immature grain. Grain in the milk and dough stages has an extremely bitter taste which most birds find unpalatable. This bitterness disappears when the grain matures and does not affect palatability of the dry grain. All presently available bird-resistant hybrids have brown seed.

VARIETY TRIALS

In 1966, six bird-resistant hybrids and a bird-susceptible check were grown in replicated trials at six locations, with a seventh bird-resistant hybrid included at one location. The 1966 yield summary is shown in Table 1. Yields in all cases are reported in 56 lb. bushels corrected to 13.5 percent moisture.

Information from the Wooster location (the Ohio Agricultural Research and Development Center) on height, number of days to 50 percent bloom, and moisture content at harvest is given in Table 2.

The most important information obtained from the 1966 trials was that bird-resistant hybrids suffered almost no bird damage. The bird-susceptible check was 100 percent destroyed at four of the six locations and corn growing near the plots at several locations suffered heavy damage from birds.

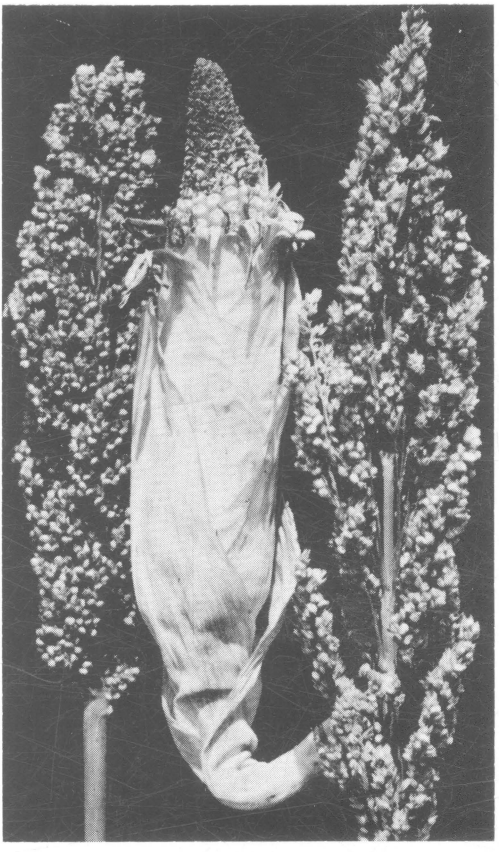
Yields in 1966 were excellent. They ranged from 67 to 190 bushels per acre, indicating a yield potential similar to that of corn. The highest yielding test was at Oak Harbor, the location with the highest blackbird population.

TABLE 1.—1966 Grain Sorghum Yields in Bushels per Acre.

Hybrid	Wooster (Wayne Co.)	North Central Branch (Erie Co.)	Western Branch (Clark Co.)	Southern Branch (Brown Co.)	Southeastern Branch (Meigs Co.)	Oak Harbor (Ottawa Co.)	Average Yields
AKS 614	90	120	151	90	103	190	124
DeKalb BR 60	67	98	132	77	91	179	107
Excel Bird-Go	98	114	154	90	109	171	123
Ga. 615	88	115	157	81	105	157	117
Northrup, King Savanna*	—	—	—	—	—	170	—
RS 617	94	117	154	74	103	163	118
RS 610†	0	0	127	0	91	0	36

*Savanna was seeded at Oak Harbor only.

†RS 610 is bird-susceptible and was 100 percent damaged at four locations.



Bird-resistant sorghum on left was not damaged but no grain remains on susceptible sorghum at the right. Corn was 10-15 percent damaged. All three plants were growing within a few feet of each other at the North Central Branch.

TABLE 2.—Agronomic Data from the 1966 Wooster Trial.

Hybrid	Height (In.)	Days to 50 Percent Bloom	Moisture Percent (Heads)*
AKS 614	40	74	19
DeKalb BR 60	44	86	41
Excel Bird-Go	50	76	30
Ga. 615	49	76	28
RS 610	38	72	—†
RS 617	44	70	23

*Trial was hand harvested and moisture percentage was calculated for entire head rather than grain alone.

†No data were obtained because of bird damage.

TABLE 3.—1967 Grain Sorghum Yields in Bushels per Acre.

Hybrid	Wooster (Wayne Co.)	North Central Branch (Erie Co.)	Northwestern Branch (Wood Co.)	Western Branch (Clark Co.)	Southern Branch (Brown Co.)	Southeastern Branch (Meigs Co.)	Oak Harbor* (Ottawa Co.) 1	Oak Harbor* (Ottawa Co.) 2	Average Yields†
AKS 614	69	127	148	115	124	163	88	62	124
Ark. 62004‡	51	71	97	107	121	145	22	23	99
Ark. 62005‡	19	77	91	86	108	118	16	22	83
DeKalb BR 60	51	106	124	118	129	158	64	33	114
DeKalb BR 62	58	94	141	125	121	165	61	42	117
Excel Bird-Go	58	107	151	126	143	192	61	46	130
Frontier 409	49	126	136	124	116	165	76	61	119
Ga. 615	52	104	144	114	140	171	63	47	121
McNair 546	65	121	143	101	119	157	76	64	118
Northrup, King Savanna	70	122	135	117	117	165	79	66	121
RS 610**	—	—	—	0	0	153	—	0	—

*Both Oak Harbor trials suffered frost damage.

†Oak Harbor yields are not included in averages.

‡Ark. 62004 and 62005 were experimental hybrids.

**RS 610 is not bird-resistant.

In 1967, ten bird-resistant hybrids were grown in replicated trials at eight locations, with a bird-susceptible check included at four of these locations.

Results were similar to those of 1966. There was no apparent bird damage to the bird-resistant hybrids and yields ranged up to 192 bushels per acre. There were, however, some low yields. The Wooster location suffered from midsummer drought. Varieties at the two locations near Oak Harbor did not reach maturity before frost because they were planted late in dry soil, with resulting slow emergence and delayed maturity.

Yield results for 1967 are shown in Table 3. As in 1966, the grain at harvest date was too wet for safe storage. Delaying harvest would not have been feasible because of the increasing probability of bad weather and because the grain becomes susceptible to bird depredation after maturity. It should be pointed out that sorghum grain, as with other grain, becomes mature before it becomes dry enough for safe storage. Grain sorghum should be at approximately 13.5 percent moisture for safe, long-term storage.

Height, number of days to 50 percent bloom, and moisture content information for 1967 for the Wooster location are given in Table 4. Plants were shorter and later maturing in 1967 than in 1966 because of low summer rainfall in 1967.

Grain sorghum was tested at six locations in 1968. Eleven bird-resistant hybrids and one partially resistant hybrid were included at all six locations, with an additional resistant hybrid at four locations. One or two bird-susceptible checks were also grown at all locations.

TABLE 4.—Agronomic Data from the 1967 Wooster Trial.

Hybrid	Height (In.)	Days to 50 Percent Bloom	Moisture Percent (Grain)*
AKS 614	30	87	22
Ark. 62004	34	92	30
Ark. 62005	26	92	32
DeKalb BR 60	31	98	32
DeKalb BR 62	35	96	29
Excel Bird-Go	40	91	32
Frontier 409	33	92	33
Ga. 615	36	92	28
McNair 546	32	89	23
Northrup, King Savanna	33	82	21

*Trial was combine harvested and moisture percentages were calculated on grain.

TABLE 5.—1968 Grain Sorghum Yields in Bushels per Acre.

Hybrid	Wooster (Wayne Co.)	North Central Branch (Erie Co.)	Northwestern Branch (Wood Co.)	Western Branch (Clark Co.)	Southern Branch* (Brown Co.)	Southeastern Branch (Meigs Co.)	Average Yields†
Acco R-1023	—	—	66	—	—	—	—
Acco R-1093	110	131	67	124	75	130	106
AKS 614	113	136	83	134	83	138	114
AKS 653	96	119	64	106	28	115	88
DeKalb BR 60	105	131	—	120	—	—	—
DeKalb BR 62	76	132	66	137	37	148	99
DeKalb BR 64	86	140	67	124	60	152	105
Excel Bird-Go	98	136	70	145	39	138	104
Excel Bird-Go 3	86	125	58	103	63	125	93
Frontier 409	105	137	82	127	81	140	112
Ga. 615	99	135	70	126	63	150	107
McNair 546	105	139	77	119	89	141	112
Northrup, King Savanna	110	129	73	120	92	128	109
Northrup, King 125†	59	35	59	67	4	95	53
RS 610†	—	—	—	—	3	134	—
DeKalb A 25†	85	88	37	96	6	92	67

*Plats were damaged by sparrows.

†A25 is partially bird-resistant and NK 125 and RS 610 are not bird-resistant.

Yields were similar to those obtained in 1966 and 1967 in most cases. Wooster yields were higher than in previous years because of better growing conditions. Yields at the Northwestern Branch were lower because of a poor stand and those at the Southern Branch were lower because of bird damage.

Sparrows or similar birds (not blackbirds) destroyed much of the grain at the Southern Branch. It is probable that this situation would not exist on large fields of sorghum. Yield data for 1968 are shown in Table 5. Other information is shown in Table 6 for the Wooster location.

Three years of variety trials indicate that all bird-resistant hybrids tested had good yield potential at all locations where tests were conducted. All varieties for which claims of bird resistance were made proved to be resistant to attack by red-winged blackbirds if grain was harvested shortly after a killing frost.

Hybrids differed in maturity and earlier hybrids tended to produce drier grain at harvest. This factor would make the earlier types more attractive economically because drying costs would be lower.

Hybrids also differed in height. Some approached a height which would make combining difficult. It is generally assumed that grain sorghum taller than about 4½ feet is not easily combined.

TABLE 6.—Agronomic Data from the 1968 Wooster Trial.

Hybrid	Height (In)	Days to 50 Percent Bloom	Moisture Percent (Grain)*
Acco R-1093	50	78	17
AKS 614	50	74	19
AKS 653	45	78	15
DeKalb A 25	43	64	13
DeKalb BR 60	53	78	17
DeKalb BR 62	60	80	20
DeKalb BR 64	53	81	24
Excel Bird-Go	58	78	20
Excel Bird-Go 3	50	79	15
Frontier 409	50	78	15
Ga 615	60	78	18
McNair 546	46	78	15
Northrup, King Savanna	48	70	15
Northrup, King 125	46	65	13

*Trial was combine harvested and moisture percentages were calculated on grain.

ROW SPACING AND RATE OF SEEDING TRIALS

The 1966 variety trials were planted in both 30 and 40-inch rows, depending upon location. Observations of leaf canopies indicated that 30-inch rows were more desirable, although no direct comparisons could be made. In the 40-inch rows, much of the soil surface was not shaded and it appeared that there was excessive moisture loss from evaporation.

The Wooster variety trial in 1966 included seeding rates of 6, 11, 16, and 21 lb. per acre. Resulting yield differences were inconsequential and there was no indication that varieties responded differently to the different seeding rates.

In 1967 and 1968, special trials were grown at the Wooster and North Central Branch locations. In these four trials, AKS 614 was planted in 7, 14, 21, and 28-inch rows and at each row spacing was seeded at 8, 12, and 16 lb. per acre. The data obtained from these trials are shown in Table 7.

At the Wooster location in 1967, all treatments yielded nearly alike. Moisture was limiting and this probably accounted for the lack of treatment effect. In 1968, rate of seeding had no effect at Wooster but row spacing effects were large, with the 7-inch rows yielding 26 bu. per acre more than the 28-inch rows. Moisture conditions were good in 1968, as shown by the yield levels obtained.

TABLE 7.—Yields from Row Spacing and Rate of Seeding Trials with AKS 614 Hybrid Grain Sorghum.

	Wooster		North Central Branch	
Variable	**1967**	**1968**	**1967**	**1968**
Row Spacing	**Average Yields in Bushels per Acre***			
7 inch	76	136	118	138
14 inch	79	126	120	132
21 inch	79	126	125	123
28 inch	72	110	119	106
Rate of Seeding	**Average Yields in Bushels per Acre†**			
8 lb. per acre	78	124	113	124
12 lb. per acre	75	125	124	123
16 lb. per acre	77	125	124	127

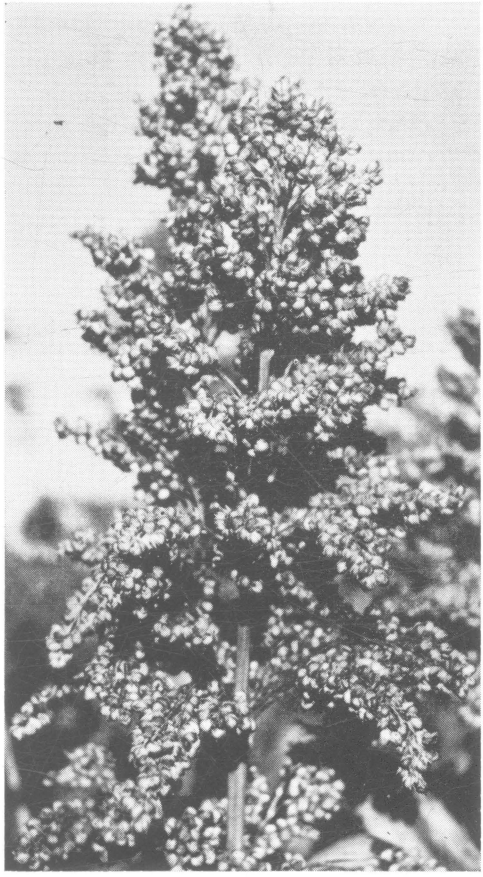
*Averages of the three seeding rates.

†Averages of the four row spacings.

At the North Central Branch in 1967, row spacing had little effect but there were differences due to rate of seeding. The 12 and 16 lb. per acre rates yielded 9 bu. per acre more than the 8 lb. per acre rate. In 1968, the opposite occurred, with row spacing having large effects and rate of seeding having small effects. The 7-inch rows yielded 32 bu. per acre more than the 28-inch rows at the North Central Branch in 1968.

The rate of seeding-row spacing studies are inconclusive because the 2 years gave different results. This is probably due to the fact that 1967 was a dry year and 1968 was a relatively wet year for sorghum. The general conclusion can be drawn that approximately 12 lb. per acre is an adequate seeding rate.

Row spacing conclusions are more difficult. Based on yield alone, it would seem that a row spacing of 7 inches is best. However, such a



A typical open-headed, brown-seeded, bird-resistant grain sorghum head.

row spacing is difficult to achieve at the seeding rates desired and could result in weed control difficulties if herbicides are not used or if they fail for some reason to control weeds.

The 28-inch spacing was as good as narrower rows in 1967. Although this was not true in 1968, it is still concluded that the 28-inch row spacing is most desirable until more data are obtained. Presumably a 30-inch spacing would give results very similar to the 28-inch spacing which was used in the trials because of equipment limitations.

DATE OF SEEDING TRIALS

Because of lack of information in Ohio, results from other states were used to determine seeding dates for variety trials in 1966. These trials were planted the last week in May or the first week in June. Although all varieties reached maturity before frost, it was apparent that an early frost would have caused damage to late maturing varieties.

Therefore, in 1967 an attempt was made to plant earlier. All but two trials were planted before May 25. The two trials at Oak Harbar were planted the first week in June and they did not reach maturity before frost.

Two special trials including three hybrids were grown in 1967 to determine the best seeding date (Table 8). At Wooster, three hybrids were planted at weekly intervals from May 18 to June 15. All hybrids yielded most from the May 18 planting date and least from the June 15

TABLE 8.—Yields from 1967 Date of Planting Trials.

Variable: Date of Seeding		Wooster	North Central Branch
Wooster	North Central	Average Yields in Bushels per Acre*	
5/18	5/23	51	102
5/25	6/2	43	92
6/1	6/9	39	96
6/8	6/16	28	61
6/15	6/25	7	31
Hybrid		**Average Yields in Bushels per Acre†**	
AKS 614		41	88
Savanna		46	84
BR 60		14	58

*Averages of the three hybrids.

†Averages of the five seeding dates.

TABLE 9.—Yields from 1968 Date of Planting Trials.

Variable			
Date of Seeding		Wooster	North Central Branch
Wooster	North Central	Average Yields in Bushels per Acre*	
6/5	5/13	113	143
6/14	5/20	81	131
	5/27	—	141
	6/3	—	138
	6/10	—	112

Hybrid	Average Yields in Bushels per Acre†	
AKS 614	101	136
Savanna	94	129

*Averages of the two hybrids.
†Averages of the two (Wooster) or five (North Central) seeding dates.

planting date. The decrease in yield due to later planting was greatest for the latest maturing of the three hybrids. Table 9 also shows that very similar results were obtained in 1967 from the North Central Branch trial.

The date of seeding trials were repeated in 1968 with similar results (Table 9). Planting was delayed at the Wooster location until June 5 because of wet soil but June 5 proved to be a superior planting date to June 14.

At the North Central Branch, weekly plantings began on May 13 in 1968 and ended on June 10. The May 13, 20, 27, and June 3 dates gave similar results but yields from the June 10 planting date were depressed (Table 9).

Based on the limited data available in Ohio, it would seem that the best date for seeding grain sorghum is about 1 week after the optimum date for corn. Planting should be completed before the end of May. However, yield decreases from planting in the first week in June are not great and good yields are possible even from early June plantings.

FERTILIZER TRIALS

All variety trials were fertilized according to current recommendation for 150 bu. per acre corn. Two trials with varying nitrogen rates indicated that corn recommendations are adequate for grain sorghum.

HERBICIDE TRIALS

Chemical weed control was used on all variety and cultural trials. Milogard (propazine) or atrazine were used at 2.5 lb. per acre as an overall pre-emergence spray. Both chemicals successfully controlled weeds on all trials. No damage to the sorghum was observed.

One herbicide trial included atrazine and milogard applied before planting at 2 and 4 lb. per acre. The same trial included a check with no treatment and plots with one, two, and three cultivations. All herbicide-treated plots yielded the same. The check was very weedy and low in yield. Cultivation caused yields to increase but it took three cultivations to obtain yields approaching those obtained on the herbicide-treated plots.

The herbicide trial was conducted on sandy soil so results may not be applicable on all soils. However, observations made on the variety trials indicate that either milogard or atrazine are excellent herbicides for grain sorghum. Other herbicides are available but were not evaluated in these tests.

GRAIN QUALITY

Quality tests were not made in most cases. However, visual observation of the harvested grain indicated good quality in nearly all cases.

TABLE 10.—Percentage Crude Protein in the Grain from the 1968 Wooster and North Central Branch Trials.

	Percent Crude Protein (Grain)	
Hybrid	Wooster	North Central Branch
Acco R-1093	11.0	9.2
AKS 614	10.8	9.2
AKS 653	10.1	9.1
DeKalb A 25	10.6	9.3
DeKalb BR 60	10.0	9.9
DeKalb BR 62	10.1	8.8
DeKalb BR 64	9.9	8.7
Excel Bird-Go	10.5	9.0
Excel Bird-Go 3	10.0	9.0
Frontier 409	9.9	9.0
Ga. 615	10.6	9.2
McNair 546	10.2	9.5
Northrup, King Savanna	10.1	9.4
Northrup, King 125	11.2	10.4

At the present time, all grain from bird-resistant varieties is brown and this has tended to lower the quality rating of this type of seed in the grain sorghum markets. This is an unfortunate situation because feeding trials and chemical analysis do not indicate that brown seed has inferior quality.

In 1968, crude protein analyses were run on the North Central Branch and Wooster trials (Table 10). Differences were small and probably were not important. There was a location difference, with the Wooster location having a higher percentage crude protein but a lower yield than North Central.

OTHER USES

Some farmers have reported success in using bird-resistant grain sorghum as silage. No data are reported here on feed value of the silage but measurements were taken on two trials concerning proportion of the plant which was grain and stalk.

Estimates from these trials indicated that approximately 50 percent of the standing crop was grain. Therefore, a field yielding 130 bu. per acre would produce 6.3 tons per acre of dry matter silage if harvested in the hard dough stage after the grain had reached maturity.

PROBLEMS

Birds

Blackbirds were not a problem except when the sorghum was not harvested shortly after frost. Sparrows or similar birds were observed feeding on the bird-resistant sorghum and damage was noted on one trial. It is not likely that they would do appreciable damage on production fields.

Insects

Corn leaf aphids did significant damage to the Wooster trial in 1967. The plots were sprayed with malathion after damage was detected and the aphids were controlled. With this exception, no other insect problem has been observed.

Diseases

Disease problems have not been observed on any grain sorghum yield trial in Ohio. A special trial planted near the Ohio River indicated that all of the bird-resistant grain sorghums which have been tested are susceptible to maize dwarf mosaic virus (MDMV). However, this would be a potential hazard only on sorghum grown in the southern part of the state where johnsongrass is common if information concerning the disease on corn applies to sorghum.

The freedom from disease on trials grown during the 3 years of test-

ing may have resulted from the isolation of these trials from other sorghum. Disease problems can be expected if sorghum acreage is increased.

Harvesting

Plots were harvested either by hand or with a combine. Combine harvesting is quite satisfactory if correct adjustments are made to the machine.

Observations indicated that grain moisture should be down to approximately 25 percent before satisfactory grain separation is obtained.

Drying

In nearly all instances, artificial drying of the grain was necessary. In most cases, grain was harvested several days after a killing frost.

Moisture content varied but was usually between 15 and 25 percent. Delaying harvest would not necessarily have allowed the grain to become drier because of the wet weather commonly occurring in the fall. A grower should plan on artificial drying of the grain in most years.

Marketing

A chief problem in producing grain sorghum is finding a market. No research has been done in this area but farmers who have grown grain sorghum in Ohio have had some difficulty in selling the crop. The problem in marketing results because the volume has been too small to make this crop worthwhile for most dealers to handle. When or if the acreage becomes substantial, this problem will no longer exist.

Because of the lower feeding value of sorghum as compared to corn, the price for sorghum grain is generally less than that of corn. A new producer of sorghum should investigate the pricing structure and possible outlets for the grain before making a decision to grow grain sorghum.

Feeding

Feeding research is not covered by this report. However, it is known that the feed value of grain sorghum tends to be less than that of corn. Grinding or cracking the grain increases its feed value for most classes of livestock. Research is underway at several locations to determine whether other grain modifications might increase feed value even further.

Information gained from 3 years of testing bird-resistant grain sorghum indicates that the crop is a feasible alternative to corn in any area of Ohio where corn production is difficult or impossible because of the red-winged blackbird.

The following can be used as a tentative guide for production of grain sorghum in Ohio.

1. Fertilize according to recommendations given for corn, with similar yields expected under most situations.
2. Prepare conventional rowcrop seedbed.
3. Use a pre-emergence herbicide at rates recommended for corn.
4. Use a corn planter equipped with sorghum plates set to plant approximately 12 lb. per acre.
5. Plant in 30-inch rows.
6. Plant about 1 week later than the recommended date for corn. However, planting can be delayed about 3 additional weeks with only a slight yield reduction.
7. At present, no insect or disease treatment is recommended on a general basis. It is possible that severe corn leaf aphid infestations may develop and these should be controlled.
8. Harvesting should be done after a killing frost with a combine equipped with a small grain header.
9. The grain should be artificially dried to 13.5 to 14 percent moisture for safe storage.
10. Expect slightly less feed efficiency than would be obtained from corn. Grinding the grain before feeding is necessary.

The State Is the Campus for Agricultural Research and Development

Ohio's major soil types and climatic conditions are represented at the Research Center's 11 locations. Thus, Center scientists can make field tests under conditions similar to those encountered by Ohio farmers.

Research is conducted by 13 departments on more than 6200 acres at Center headquarters in Wooster, nine branches, and The Ohio State University.

Center Headquarters, Wooster, Wayne County: 1953 acres
Eastern Ohio Resource Development Center, Caldwell, Noble County: 2053 acres
Jackson Branch, Jackson, Jackson County: 344 acres
Mahoning County Farm, Canfield: 275 acres
Muck Crops Branch, Willard, Huron County: 15 acres
North Central Branch, Vickery, Erie County: 335 acres
Northwestern Branch, Hoytville, Wood County: 247 acres
Southeastern Branch, Carpenter, Meigs County: 330 acres
Southern Branch, Ripley, Brown County: 275 acres
Western Branch, South Charleston, Clark County: 428 acres